

Questions from Medical biology and Genetics
in acad. year 2025/2026
for 1st year Dentistry

I. The cell

1. Microscopy techniques and their utilization in biology.
2. Types, shapes and sizes of the cells.
3. Differences between prokaryote and eukaryote cells.
4. Molecular structure of the biological membranes.
5. Cell transport.
6. Cell junctions - structure and function.
7. Types of intercellular communications (endocrine, paracrine, autocrine and neural).
8. Types and function of signal molecules, first and second messengers, amplification of signal.
9. Membrane receptors - structure and function.
10. Cytoplasm - structure and function.
11. Cell nucleus – structure and function.
12. Ribosomes – structure and function.
13. Endoplasmic reticulum - types, structure and function.
14. Golgi complex, its structure, metabolic and distribution function.
15. Lysosomes as a part of intracellular digestive system. Proteasomes – structure and function.
16. Peroxisomes – structure and function.
17. Structure and function of mitochondria, endosymbiotic theory.
18. Cytoskeleton - types of its structures, function.
19. Cell cycle - phases, regulatory molecules, checkpoints (overview).
20. Processes taking part in cell cycle regulation, examples.
21. Mitosis as a part of cell cycle (overview).
22. Cell cycle checkpoints – principle, key molecules.
23. Meiosis – stages and biological significance.
24. Spermatogenesis and oogenesis in humans.
25. Cell and tissue cultures, their significance in biology and medicine.
26. Extracellular vesicles and their significance in medicine.
27. Stem cells (definition, types and utilization in biology and medicine).
28. Tissue engineering and regenerative medicine.
29. Apoptosis - programmed cell death (telomeric sequences).
30. Mechanism of apoptosis activation through death receptors.
31. Mechanism of apoptosis activation through mitochondrial pathway.
32. Mechanism of apoptosis activation through endoplasmic reticulum.
33. Viruses as an independent group of organisms and their taxonomy.
34. Reproduction of viruses (lysogenic and lytic cycle, molecular mechanism – retroviruses (HIV)).
35. Mutations and recombinations of viruses (influenza, retroviruses), reasons and consequences.
36. Mechanisms of reverse transcription (cDNA synthesis), origin of HIV provirus.
37. Oncoproteins of DNA viruses (HPV, SV40, EBV) in malignant transformation of cell (overview).
38. Interactions between micro – and macroorganisms.

II. Chromosomes, genes, genome, inheritance, malignancy, mutagenesis

1. Basic methods of human genetics
2. Chromosomal basis of inheritance, types of chromosomes, human karyotype.

3. Ultrastructure of chromosome – nucleosome, non-histone proteins, chromatin and mechanisms of its remodeling.
4. Classical cytogenetics, indications for cytogenetic testing. Methods of chromosomes staining.
5. Identification of chromosomes in interphase nucleus, principle, utilization.
6. Molecular cytogenetic methods (overview).
7. Disorders of mitotic and meiotic division (non-disjunction, anaphase lag) and their consequences.
8. Numerical aberrations of chromosomes – types, mechanisms of origin.
9. Spectrum of chromosomal aberrations in miscarriages, newborns and in the adult population.
10. The most common numerical chromosomal aberrations in neonatal population (Down sy., Turner sy.) – compare the mechanism of origin.
11. X-chromosome inactivation, reasons, mechanisms and consequences.
12. Gene dose effect, consequences of allele amplification.
13. Mosaicism – definition, origin, the influence on the clinical signs.
14. Mechanisms causing deregulation of cell cycle and its consequences.
15. Oncogenesis, molecular characteristics of gradual malignant transformation of cell.
16. Relation between protooncogene - oncogene, types of oncogenes.
17. Tumor-suppressor genes and proteins – types, function, significance in cell cycle regulation.
18. Autosomal dominant inheritance, criteria, most common diseases with autosomal dominant inheritance, new mutations, selection against them.
19. Autosomal recessive inheritance, criteria, most common diseases with autosomal recessive inheritance, selection, detection of recessive alleles.
20. X-chromosome linked inheritance, most common diseases with this type of inheritance.
21. AB0 system, inheritance, antigen and antibody, compatibility, rules of transfusion.
22. Rh factor and hemolytic disease of newborns – mechanism of origin and prevention.
23. Multifactorial and polygene inheritance, criteria (continual and discontinual variability).
24. Normal variation in population, tendency to average values, traits with threshold effect (oro-facial clefts and neural tube defects).
25. Hardy-Weinberg law, gene frequencies in population, gene-pool of population, consanguinity - influence on allele frequency in population.
26. Mutagenesis – molecular base, types of mutations.
27. Mutagens – characteristics, types, mechanisms of action, possibilities of their detection.
28. Somatic and gametic mutations, consequences.
29. Congenital developmental defects – characteristics, incidence in human population, possibilities of study.
30. Molecular mechanisms governing embryogenesis (SHH, HOX, PAX).
31. Apoptosis in embryogenesis.

III. Molecular genetics

1. Composition, function and structure of DNA.
2. Complementarity of bases and its importance. Watson-Crick model of DNA (alpha helix).
3. Genetic code and its degeneration.
4. Semiconservative replication of DNA.
5. Central dogma of the molecular genetics, flow of genetic information (Crick, Temin-Baltimore).
6. Structure of eukaryotic gene (regulatory, coding and non-coding regions).
7. Characteristics of human nuclear genome, types of sequences in DNA.

8. Transcription in eukaryotes. Post-transcriptional modification of pre-mRNA.
9. Translation – origin of initiation complex and active ribosome, elongation and termination.
10. Inhibition of protein synthesis, mechanism of antibiotics action.
11. RNA types in eukaryotic cell (overview), their characteristics and function.
12. Gene families (hemoglobin genes, HOX) – mechanism of origin, characteristics.
13. Forms of alien DNA entry into the cell – conjugation, transduction, transformation, transfection.
14. Restrictive endonucleases, characteristics and function of enzymes, utilization in practice.
15. DNA recombinant techniques, principle, utilization.
16. Genetic vectors – types, characteristics.
17. Genetically modified organisms.
18. Fluorescent in situ hybridization (FISH), principle, utilization.
19. DNA polymorphisms – examples and utilization (VNTR, RFLP), possibilities of identification.
20. DNA fingerprint method and its practical application.
21. DNA sequencing, principles, utilization.
22. Gel electrophoresis, Southern blot, Northern blot, principles, utilization.
23. PCR – principle of method and its utilization in diagnostics.
24. DNA - DNA hybridization and its practical application.
25. Principles, advantages and limits of gene therapy.
26. Approved products and diseases using gene therapy.

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